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GEOLOGY.*

Mr. Lyell is foreign secretary to the Geological Society, and before entering upon the review of his able and interesting work, we wish to advert briefly to the general proceedings of the society of which he is so distinguished a member. The abstract question of the amount of advantage derived to science from such learned bodies, we shall not here discuss: yet remembering that education usually derives more from the principle of exciting emulation, or the desire of excelling others, than from that of pointing out the deep-rooted pleasure to be plucked by its cultivators from knowledge itself, we cannot doubt that they do good by affording the excitement rendered necessary by habit; and by furnishing an arena into which the most illustrious competitors for mental distinction may deem it honorable to enter. The meetings of such bodies exercise a powerful attraction on men of intellect drawn round their foci:—in none is the impulse to ‘assemble themselves together’ stronger, or the gratification afforded of a higher order, than in those of the Geological Society. Wonderful has been the recent progress made in the science there illustrated: its admirers no longer indeed acknowledge imagination as their ruling goddess; but reason, though its sway be more rigid, has still left open an ample prospect of things true yet more marvellously strange than ever did her rival conjure up to dazzle and bewilder her votaries. We allude here to those vast and extraordinary relics of former worlds and states of existence, rescued from their tombs by modern geologists, and held up to the contemplation of philosophers who gaze with equal awe and admiration at such new manifestations of the infinity of the creative power and will. The interest of the subject, deep in itself, is at these meetings greatly heightened by *vivâ voce* discussion, nor is the result of these animated debates limited to transitory gratification; the advantages springing from them are far more important. Whilst such a system continues it is scarcely possible that truth should remain obscured or hidden, or that error should stalk on unexposed. In the stream of light poured out by the great luminaries of science, the tints of the one glow with encreasing brilliancy whilst the false colors of the other fade away and sink into the shade. How often, indeed, would the gem have remained unnoticed among obscuring heaps of worthless rubbish, had not this concentrated light shone upon and called it, as it were, into bright existence. The pleasures of such meetings can only be felt and appreciated by those who have been present at them: the charm of dwelling upon them, even in memory, has seduced us from the graver business of considering the papers read; and we shall now close our preface by expressing a hope that the recent establishment of the Zoological Society in Dublin, may lead to that of other societies, in which men who have learned to think may partake of one of the greatest of earthly enjoyments—the interchange of knowledge.

The session of the Geological Society closed on the 18th of June, and a large portion of the allotted time for reading of that evening, as well as of that of the 4th, was devoted to a paper by Mr. Weaver, on the S. W. of Ireland.† The skill and experience of that able geologist cause his appearance on the field to be, at all times, eagerly hailed—

* Lyell's *Principles of Geology*, Vol. I.—London, Murray.

† See an abstract of Mr. W's. paper, at the back of the book.

we look forward with much pleasing anticipation to the future volume of the society's transactions, which will contain his paper in a perfect shape, unshorn of its sections and other illustrations. Mr. Weaver describes the greater part of this extensive district as composed of transition rocks, having an E. and W. direction, and a N. and S. dip; the central beds being vertical, whilst those on each side become (gradually more and more) horizontal as they recede from the centre. This arrangement prevails particularly in Kerry, and extends also into Cork and Waterford. Towards the North, as in Clare, the ridges decrease in elevation and the transition rocks pass under the old red sandstone and mountain limestone. Considering the curious conglomerates which cap some of the highest mountains of the country, such as Monavoula, the Galtees, &c. as appertaining to the old red sandstone, their connection with the transition rocks is the same; yet here we cannot but observe that these conglomerates deserve a very careful examination, and that a detailed section through Monavoula and the Galtees, taking in the intermediate low country, would throw much light upon the mutual relations of all the rocks. We have touched but slightly on the general geology of this paper, the accuracy of which rests safely on the known ability of its author, and shall now proceed to comment on two points of great geological importance, which we have selected from the rest of the memoir. The first of these is the geological position of the Munster coal, which Mr. Weaver shows to be, excepting that of Clare, transition.

Respecting the place which the great coal formation (leaving out of the question the minor and less important deposits of this mineral,) occupies in the geological series, as shown by its accompanying rocks, our readers will doubtless remember that continental and English geologists have differed in opinion. The latter once connected the mountain or carboniferous limestone, and the subjacent old red sandstone with secondary rocks, and supposing the great deposition of coal to be constantly above these two formations, it also would necessarily be secondary. This reasoning was founded on an examination of much of the coal of England, and a want of conformability between the old red sandstone and transition rocks below it. Geologists on the continent taking their impressions from other sources, linked the old red sandstone to the Greywacke, and disputed the propriety of separating the carboniferous or mountain limestone from transition rocks, thus approximating the coal to the latter. In Messrs. Conybeare and Phillips' "Outlines," the carboniferous rocks are formed into a distinct groupe, "the medial" alike separated from the secondary and transition. Mr. Conybeare's words are—"This series of rocks is by some geologists referred to the *flotz*, by others to the transition class of the *Wernerians*: we have preferred instituting a particular order for its reception, a proceeding justified by its proportional importance in the geological scale, its peculiar characters, and the many inconveniences arising from following either of the above conflicting examples;" and again: "Had we been obliged to refer it either to the *flotz* or transition class of the *Wernerians*, we should not have hesitated in preferring the latter branch of the alternative, since at least ten characters will be found in common between the carboniferous and transition class, for one which would lead to an opposite arrangement." By this insulation of the coal and accompanying rocks, the difference between geologists is reduced within narrower limits, but not obliterated; hence the contest still continues. Mr. Bakewell joins the old red sandstone

to the greywackes, and places the mountain limestone also, amongst transition rock; he leaves, however, the actual coal strata amongst the secondary. M. Brongniart in his last work, "*Tableau des Terrains qui composent l'écorce du Globe, &c.*" thus strongly expresses his opinion on this subject:—"English geologists distinguish their carboniferous limestone from transition rocks, either by that particular appellation, or by the term upper transition. They admit another inferior limestone considered transition, and containing trilobites; but it does not appear that M. d'Omalins makes out any real difference between his 'terrain anthraxifere' and transition limestones, since he places immediately below them the formation which he calls 'ardoisier,' a part, according to all geologists, of the transition series. This manner of viewing the question confirms me in the opinion that the rocks below the coal, whatever may be their nature, can neither be distinguished nor separated from transition rocks; and that the carboniferous groupe should be suppressed, since it was but a repetition of the calcareous, or limestone groupe of transition rocks." It appears to us that the strongest arguments in favour of the carboniferous groupe, should be drawn from its convenience, and from an established constancy in its relations. Mr. Conybeare relied on that constancy, and describes the great coal formation as "interposed between the newer red or saliferous sandstone, and the great carboniferous limestone and older sandstone formations: or, where these are absent, resting on transition rocks." Words which clearly define the fixed position of this remarkable formation, and imply that though it may, from the deficiency of a stratum or strata (a phenomenon not uncommon in geology,) rest on transition rocks, there is no real alteration in its relative position, or inversion of the usual order of arrangement.

More extended observations seem, however, if not, to decide against, at least to throw considerable doubt upon this simplicity and uniformity of arrangement. Professor Ledgewich in his able address to the Geological Society, thus expresses himself on this very subject:—"Even the history of our coal formations is not yet perfect. The association of the coal and mountain limestone of Northumberland has not been well explained. The great corresponding deposits of Cumberland are undescribed; nor does it appear in our published works, that coal is found alternating in the North of England with all parts of the mountain limestone group; and that beds of coal are worked in several places, resting upon transition slate, and surmounted by the whole limestone series." What can be more conclusive than these words against the principle on which the carbonaceous group was first formed?

The memoir of Mr. Weaver expands our view still further; for not only does it show us the coal below the old red sandstone, but in the very same section, (for Clare may be considered as the northern extreme of that section,) coal above the sandstone and ordinary mountain limestone. It may now be asked what is our conclusion? We shall briefly state it thus—Looking at the identity, or near approach to identity, of those fossils which occur in the transition and in the mountain limestone; at the strong resemblance of the old red sandstone to some varieties of Greywacke; at the occurrence of parts of the great coal deposit sometimes above the mountain limestone, sometimes alternating with, and sometimes below it, we are led to recognise a continuance of the same types of animal and vegetable existence through the whole series: thus using the coal as an additional link of evidence, and combining it with ordinary fossils to strengthen the proof of identity

of formation in these rocks; and that, notwithstanding the partial disturbance or suspension by extraneous causes of the progress of formation, sometimes acting after the coal had been fully developed, sometimes prior to its appearance, and sometimes in the very course of its deposition.

The second point reserved for notice, refers to the mode in which metallic particles usually combined together in veins, apparently the result of injection or intrusion, are, in many parts of the district described by Mr. Weaver, disseminated through the rocks. Ordinary veins we may either consider as fissures or cracks, existing prior to the deposition of metallic matter, and filled up subsequently by infiltration, according to some, or by injection from below, or by sublimation: or we may suppose the cracks or fissures to be formed by the same powerful cause which has forced the mixed minerals and metallic matter to flow into them; or finally, as being the effect of the very efforts of that matter to escape. It is not our intention to enter into a close examination of the reasons for or against any of these views; but we shall say this much, that in our opinion evidence is in favour of the filling from below, since had it been effected from above, we ought to see some traces of a similar infiltration at much more recent periods; and further, that from the magnitude of many of these veins, their extent, the various rocks through which they pass, and the length of time which the operation of filling by infiltration must have consumed, we might have expected for less uniformity of crystalline structure, and much more frequent alternations from earthy to fragmentary, and again to crystallized substances. Veins do not, however, always form a channel of communication with the great internal sources from which metallic matter may be presumed to proceed: they are frequently mere isolated threads of stony or metallic matter shut up in the mass of rock. In this case they are supposed, and we think rightly, to have proceeded from the separation consequent upon molecular attraction, of particles either earthy or metallic from the general mass whilst it was yet in a semifluid state, and opposed but a partial barrier to the movement of its molecules.

In a former memoir on the valley of Brownstown, in Meath, Mr. Weaver has given examples of these isolated or contemporaneous veins; in the present he adds many others, (as in the copper mines of Ross Island,) where no regular vein occurs, the metal being there dispersed irregularly in ribs, branches, strings, &c. similarly to calcareous spar in limestone. The separation by molecular attraction of the metallic particles implies necessarily their previous dissemination in the rocky mass. Brongniart, in his work already alluded to, speaking of the schiston portion of transition rocks, observes: "This formation is one of those in which mineral and more especially metallic deposits most abound. They occur in it as frequently in veins as in threads or strings. Sometimes in layers and even in beds, scarcely ever disseminated in the substance itself of the rock." Mr. Weaver's paper comes opportunely to illustrate the latter of these modes of distribution, since it shows that in part of the county of Cork, the diffusion of cupreous particles is of common occurrence; and to such an extent that in 1812 a cupreous peat bog existed on the east side of Glandore harbour, 40 or 50 tons of the dried peat yielding one ton of ashes, *which produced from ten to fifteen per cent of copper*, a fact as curious as it is convincing. We here close our observations on Mr. Weaver's paper, regretting that the space we have devoted to it, totally precludes the possibility of noticing the interest-

ing paper by Colonel Silvertop on the geology of part of Grenada, which closed the proceedings of the session. As, however, that paper may be considered the sequel of one read at an earlier period of the session, we could not have satisfactorily entered into its examination, without also recurring to its precursor. We may, however, mention, that it establishes, or rather confirms the existence of nummutite limestone among the secondary as well as the tertiary rocks.

We now pass to the consideration of the volume just published by Mr. Lyell; it is entitled "An attempt to explain the former changes of the earth's surface, by reference to causes now in operation." Geology may be said to bear very nearly the same relation to physical science that history does to moral philosophy: while history relates the rise, the progress, and the gradual or sudden decay of states or societies of men, geology details the successive changes that have taken place in the organic and inorganic kingdoms of nature; history investigates the causes that have operated upon human character, and produced the modifications of society which have succeeded each other or existed contemporaneously, since the beginning of recorded time. Geology examines the circumstances which have led to every physical revolution that has taken place, and the degree of influence that these circumstances have exercised in modifying the surface and external structure of our planet. Both sciences teach us alike to judge of the present, and anticipate the future, by an accurate knowledge of the past. But we shall quote Mr. Lyell:

"By researches into the state of the earth and its inhabitants at former periods, we acquire a more perfect knowledge of its *present* condition, and more comprehensive views concerning the laws *now* governing its animate and inanimate productions. When we study history, we obtain a more profound insight into human nature, by instituting a comparison between the present and former states of society. We trace the long series of events which have gradually led to the actual posture of affairs; and by connecting effects with their causes, we are enabled to classify and retain in the memory a multitude of complicated relations—the various peculiarities of national character—the different degrees of moral and intellectual refinement, and numerous other circumstances, which, without historical associations, would be uninteresting or imperfectly understood. As the present condition of nations is the result of many antecedent changes, some extremely remote and others recent, some gradual, others sudden and violent, so the state of the natural world is the result of a long succession of events, and if we would enlarge our experience of the present economy of nature, we must investigate the effects of her operations in former epochs.

"We often discover with surprise, on looking back into the chronicles of nations, how the fortune of some battle has influenced the fate of millions of our contemporaries, when it has long been forgotten by the mass of the population. With this remote event we may find inseparably connected the geographical boundaries of a great state, the language now spoken by the inhabitants, their peculiar manners, laws, and religious opinions. But far more astonishing and unexpected are the connexions brought to light, when we carry back our researches into the history of nature. The form of a coast, the configuration of the interior of a country, the existence and extent of lakes, valleys, and mountains, can often be traced to the former prevalence of earthquakes and volcanoes, in regions which have long been undisturbed.

To these remote convulsions the present fertility of some districts, the sterile character of others, the elevation of land above the sea, the climate, and various peculiarities, may be distinctly referred. On the other hand, many distinguishing features of the surface may often be ascribed to the operation at a remote era of slow and tranquil causes—to the gradual deposition of sediment in a lake or in the ocean, or to the prolific growth in the same of corals and testacea. To select another example, we find in certain localities subterranean deposits of coal, consisting of vegetable matter, formerly drifted into seas and lakes. These seas and lakes have since been filled up, the lands whereon the forests grew have disappeared or changed their form, the rivers and currents which floated the vegetable masses can no longer be traced, and the plants belonged to species which for ages have passed away from the surface of our planet. Yet the commercial prosperity, and numerical strength of a nation, may now be mainly dependant on the local distribution of fuel determined by that ancient state of things.”

“It was long ere the distinct nature and legitimate objects of geology were fully recognised, and it was at first confounded with many other branches of inquiry, just as the limits of history, poetry, and mythology were ill-defined in the infancy of civilization. Werner appears to have regarded geology as little other than a subordinate department of mineralogy, and Desmarest included it under the head of Physical Geography. But the identification of its objects with those of Cosmogony has been the most common and serious source of confusion. The first who endeavoured to draw a clear line of demarcation between these distinct departments, was Hutton, who declared that geology was in no ways concerned “with questions as to the origin of things.” But his doctrine on this head was vehemently opposed at first, and although it has gradually gained ground, and will ultimately prevail, it is yet far from being established. We shall attempt in the sequel of this work to demonstrate that geology differs as widely from cosmogony, as speculations concerning the creation of man differ from history. But before we enter more at large on this controverted question, we shall endeavour to trace the progress of opinion on this topic, from the earliest ages, to the commencement of the present century.”

Mr. Lyell then proceeds to examine the oriental cosmogony, the cosmogonic doctrines of the Greeks, Romans, and Arabians, and proceeding to the physico-theological writers of more modern times, he presents a complete and accurate history of the theories of the earth, and the progress of opinion concerning geological science, including of course the Neptunian and volcanic theories of Werner and Hutton, down to the formation of the Geological Society in 1807. After a review of the causes which have hitherto contributed to retard the progress of geology, and the popular grounds of opposition to its doctrines, we are presented with a series of facts to establish the position that all former changes of the organic and inorganic creation are referrible to one uninterrupted succession of physical events, governed by laws now in operation.

Among these uniformly operating physical causes, one of the most active and wonderworking is the destroying and transporting power of running water, as exhibited by torrents and rivers. Some of the most familiar and at the same time remarkable illustrations of this extraordinary power are afforded by the storm and flood of this time year

in Scotland, of which Sir Thomas Dick Lauder has lately presented the public with so interesting an account. Some of the effects of the water in moving stones and other heavy materials, we shall describe in the words of Mr. Lyell:

"The floods extended almost simultaneously and in equal violence over a space of about five thousand square miles, being that part of the north-east of Scotland which would be cut off by two lines drawn from the head of Lochrannoch, one towards Inverness, and another to Stonehaven. All the rivers within that space were flooded, and the destruction of roads, lands, buildings, and crops along the courses of the streams was very great. The elements during this storm assumed all the characters which mark the tropical hurricanes: the wind blowing in sudden gusts and whirlwinds, the lightning and the thunder being such as is rarely witnessed in that climate, and heavy rain falling without intermission. The bridge over the Dee at Ballatu consisted of five arches, having upon the whole a water-way of two hundred and sixty feet. The bed of the river on which the piers rested, was composed of rolled pieces of granite and gneiss. The bridge was built of granite, and had stood uninjured for twenty years, but the different parts were swept away in succession by the flood, and the whole mass of masonry disappeared in the bed of the river. "The river Don," observes Mr. Farquharson, in his account of the inundations, "has upon my own premises forced a mass of four or five hundred tons of stones, many of them two or three hundred pounds weight, up an inclined plane, rising six feet in eight or ten yards; and left them in a rectangular heap, about three feet deep on a flat ground; and, singularly enough, the heap ends abruptly at its lower extremity. A large stone, of three or four tons which I have known for many years in a deep pool of the river, has been moved about one hundred yards from its place."

"When we consider how insignificant are the volume and velocity of the rivers and streams in our island, when compared to those of the Alps and other lofty chains, and how, during the various changes which the levels of different districts have undergone, the various contingencies which give rise to floods, must in the lapse of ages be multiplied, we may easily conceive that the quantity of loose superficial matter distributed over Europe must be very considerable. That the position also of a great portion of these travelled materials should now appear most irregular, and should often bear no relation to the existing water drainage of the country, is a necessary consequence, as we shall afterwards see, of the combined operations of running water and subterranean movements."

The action of springs, tides and currents, is developed after that of floods and rivers, and the reproductive powers of running water, in the growth and increase of deltas and the gradual silting up of estuaries, are next considered. Having duly discussed the changes wrought in the earth's surface since the times of history and tradition, as well as those which it is even now undergoing, by the continued action of aqueous causes, our author proceeds to examine those resulting from igneous agency, that is to say, from earthquakes and volcanos, a detailed account of which phenomena, so far as they have been recorded, is given. The aqueous and igneous agents are regarded as antagonist forces, the aqueous labouring incessantly to reduce the inequalities of the earth's surface to a level, while the igneous are equally active in restoring the unevenness of the crust of the globe. It is curious and useful to trace in the operation of those causes which are usually deemed the ministers only of terror and destruction, the elements of a great conservative principle in the highest degree essential to the stability of our system, and the presiding influence of that benign power which ever educes out of partial evil "universal good." We prefer reserving our opinion on some peculiar doctrines broached by Mr. Lyell until we shall have seen them more fully developed in his second volume, and in the meanwhile we willingly recommend the part of his work already published, as an able and philosophical view of the principles of geology, and of the facts upon which they are founded.